DOCUMENT RESUME

ED 226 964 SE 040 377

TITLE	Engineering Education Problems. The Laboratory Equipment Factor.
INSTITUTION	National Society of Professional Engineers, Washington, D.C.
REPORT NO	NSPE-Pub-1017
PUB DATE	Sep 82
NOTE	59p.
AVAILABLE FROM	National Society of Professional Engineers, 2029 K Street, NW, Washington, DC 20006 ($10.00 NSPE members; $20.00 non-members).
PUB TYPE	Reports - Evaluative/Feasibility (142)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Building Obsolescence; Degrees (Academic); *Engineering Education; Enrollment; *Expenditures; Higher Education; *Laboratory Equipment; *Obsolescence; Pilot Projects; *Science Equipment; Science Laboratories; Surveys
IDENTIFIERS	National Society of Professional Engineers

ABSTRACT

Presented is a pilot study focusing attention on problems of deteriorating physical plants and inadequate/obsolete equipment contributing to the current crisis in engineering education. Data are reported from a survey instrument (included in an appendix) from 26 colleges/universities, representing 168 programs out of a national total of 1212 programs. Information obtained for fiscal years 1970-71 to 1980-81 included: laboratory expenditures; faculty man years; student credit hours produced; degrees awarded; enrollment; number of student stations; separately budgeted research expenditures; base year inventory (1970-71); and laboratory credits required. Review of the data reveals that the average laboratory equipment inventory per school declined from $5,809,000 to $856,000 during the period 1971-81. Based on 250 schools, this leads to the conclusion that the cost of modernizing engineering laboratories (at the 1971 level) will be $1,238,250,000; considering the difference in enrollment between 1981 and 1971, this figure increases to $2,195,417,000. These and other results indicate that the engineering education system is currently stretched to (or beyond) its limit and that the problems of large class size, high student-to-faculty ratios, deteriorating physical plants, inadequate equipment, and inability to acquire laboratory equipment commensurate with present-day technological advances in industry are too widespread to be ignored. (JN)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

✓ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

ED226964

The Laboratory Equipment Factor

"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

Jean Robertson

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

SE040377

A PILOT STUDY CONDUCTED

BY THE

PROFESSIONAL ENGINEERS IN EDUCATION
PRACTICE DIVISION

OF THE

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

National Society of Professional Engineers
2029 K Street, N.W., Washington, D.C. 20006
NSPE Publication No. 1017
$10 NSPE Members
$20 Non-Members

TABLE OF CONTENTS

Topic	Page
Table of Contents	i
List of Tables	ii
Acknowledgments	iii
Introduction	1
Purpose	3
Executive Summary	6
Schools by Group	7
Pilot Study	13
Conclusions	31
References	33
Appendix	35

LIST OF TABLES

No.	Topic	Page
1	Group 100 Schools Summary	8
2	Group 200 Schools Summary	9
3	Group 300 Schools Summary	10
4	Group 400 Schools Summary	11
5	Group 500 Schools Summary	12
6	Program Weight Factors	14
100.1	Group 100 Basic Data	16
100.2	Group 100 Figures of Merit - Inventory	17
100.3	Group 100 Figures of Merit - Expenditures	18
200.1	Group 200 Basic Data	19
200.2	Group 200 Figures of Merit - Inventory	20
200.3	Group 200 Figures of Merit - Expenditures	21
300.1	Group 300 Basic Data	22
300.2	Group 300 Figures of Merit - Inventory	23
300.3	Group 300 Figures of Merit - Expenditures	24
400.1	Group 400 Basic Data	25
400.2	Group 400 Figures of Merit - Inventory	26
400.3	Group 400 Figures of Merit - Expenditures	27
500.1	Group 500 Basic Data	28
500.2	Group 500 Figures of Merit - Inventory	29
500.3	Group 500 Figures of Merit - Expenditures	30

ACKNOWLEDGMENTS

A note of appreciation is due to the Florida Deans of Engineering:

Dr. Glen Burdick, P.E. (USF)
Dr. Wayne Chen, P.E. (UF)
Dr. Norman Einspruch (UM)
Dr. Carl Lippold (FRAU)
Dr. Andrew Revay, P.E. (FIT)
Dr. Jeffrey Tennant, P.E. (FAU)

for their encouragement; to Mr. Jim Brunson (UF), Co-Investigator on the ASEE Planning Factor Study for assistance with definition of data elements; to Dr. George Burnet, P.E. (Iowa State) for wise counsel; and to the Board of Governors of PEE/NSPE for continued support. Mr. David Noller, E.I., graduate student in Industrial Engineering at UCF assisted with the data analysis and Ms. Jean Holt of the UCF Dean's Office Staff typed the manuscript.

For the Educational Data Committee:

Dr. Halit Kosar, P.E.
(Gannon University)
Dr. Robert Scholtes, P.E.
(Mississippi State University)
Dr. Robert Kersten, P.E.
(University of Central Florida) Chairman

INTRODUCTION

The record is clear that for nearly two centuries, beginning with George Washington's call for the establishment of an "engineering school" in 1778, the United States moved to and maintained a position of leadership among the nations of the world. What is by no means clear is the answer to the question. . .do we have the will to organize the use of our resources to preserve and maintain that position for the benefit of future generations? (1).

Surely the standard of living, the quality of life, the productive capacity of our free enterprise system became the envy of the world. Because of us or in spite of us, peoples everywhere were and are seeking to emulate the achievements of the American way. Some have now become formidable competitors.

Whereas we were once the acknowledged leaders if not pre-eminent in nearly every major technological activity, the facts are that we have lost technological leadership in automobiles, steel, optics, manufacturing and consumer electronics. If recent announcements regarding the Japanese accomplishments in the 64k RAM chip manufacture are valid, we may well be on our way to losing leadership in computers.

James Tobin, recent Nobel Laureate in Economics, in analyzing national expenditures for education and their relationship to the Gross National Product concluded that about 20% of the nation's GNP should be credited to advances in education (2). Studies by the Stanford Research Institute and the Denver Research Institute show that investments in engi- neering schools have been the source of most of the "growth" enterprises (3) in this country.

However, the decade-long decline in the flow of resources to higher education in general and engineering education in particular has taken its toll.

The University is not at the "cutting edge" anymore, and therefore our current graduates are not going to be the contributors their predecessors were. Some have said engineering education is in some distress and in need of attention (4). . .others have indicated a crisis state (5).

Engineering Education is in serious trouble. There are a multitude of problems with diverse origins and, it is hoped, with a variety of solutions. Many of the problems are truly crisis situations. Nationwide the faculty vacancy rate is nearly 10% of the total positions. The prospect of filling them is lessening as graduate enrollments decline.

At the same time undergraduate enrollments are burgeoning, spurred on by the lure of high salaries which, in turn, siphons prospective graduate students out of the system. The enrollment problem only exacerbates the deteriorating facilities and growing obsolescence of laboratory equipment problems.

The continuing loss of good faculty because of relatively poor salary and quality of working conditions presents a problem of a very insidious nature. Undoubtedly the single most important ingredient in the educational enterprise is the faculty.

The combined effect of these problems has led to a greater criticism of the product, i.e. quality of the new graduate, than at any previous time. New hires are being made under a cloud of a "not because they are what we need but because they are all that is available" attitude. Yet knowledge - especially knowledge of technology - increasingly constitutes a basic source of economic growth and rising living standards. An engineering shortage would suffocate the economy no less effectively (though less visibly) than a fuel shortage (6).

In addition to the many problems already noted, there is a considerable diversity in the training origins and utilization levels of engineers within any one discipline (5). It is this open, diverse, even pluralistic mechanism (7)

which has produced some flexibility and elasticity in the past and a reliance on engineering education to adapt, improvise and respond to demand (8). This reputation probably will serve us one more time. However, the quality level seems certain to diminish.

The roller coaster pattern of enrollments over the past 30 years has arrived at a unique confluence of events, i.e. faculty shortages, growing undergraduate enrollments, declining graduate enrollments, aging facilities and obsolescent laboratories. Seemingly, the last ounce of resiliency has been wrung out of the system.

PURPOSE

We shall focus attention in this report on "the laboratory equipment factor." The problems of deteriorating physical plants, inadequate and obsolete equipment commensurate with technological advances in the world today are too widespread to be ignored. Deficiencies in laboratory equipment directly impart the quality of engineering education.

There is ample anecdotal evidence that equipment deficiencies (obsolescence, a developing pattern of postponing equipment purchases, a continuing technological explosion, state and federal program cutbacks, inability to maintain the existing stock of aging equipment, etc.) have become a problem of first rank (9,10,11,12,13,14,15).

Obsolete instructional laboratories and facilities are mentioned nearly as often as faculty shortages as the prime obstacle to providing quality engineering education. Students who are using obsolete equipment in the university are not being properly prepared for professional practice (16).

Engineering laboratories are dependent upon fixed equipment such as motors, generators, engines, test machines, wind tunnels, etc., and on instrumentation.

The tremendous development of instruments with the discovery of the transistor and later the microprocessor has made possible the application of digital and computer techniques to all fields of measurement. This has made it possible to perform experiments in undergraduate laboratories that were impossible a few years ago with an accuracy that bares the true value of an engineering theory or design (17).

Engineering colleges have not been funded to keep up with these developments. Our students are not being adequately prepared to work with confidence in many areas of engineering.

Modern technological progress causes early obsolescence of engineering laboratory equipment. Engineering laboratory equipment is so expensive that in the typical case, such small quantities of the equipment exist that student laboratory sections must be quite small in order to allow each student the necessary time to use the equipment. Groups of students "rotate" from one piece of sophisticated equipment (e.g., an oscilloscope) to another in order to realize most cost-effective instructional benefits.

Recent comments by Accreditation Board for Engineering and Technology officials tend to indicate that nearly half of accreditation actions in recent years are for less than the maximum six year cycle. . .and the primary factor is the deteriorating condition of engineering laboratories. Clearly the quality of engineering education is suffering and current graduates are lacking essential knowledge and skills related to modern laboratory practice.

Until and unless we are willing to pay the price for excellence in engineering education (including appropriate instructional laboratories) we by and large won't produce the quality of talent needed in the nation today. In the meantime industry will hire what we produce, because that is all that is available, and not what they want. Then they will spend millions to retrain them to their own specifications.

The recapitalization of the engineering education laboratory system is essential and it is a problem for higher education of the relative magnitude of refurbishing the steel industry or retooling the auto industry. . .but it must be done.

EXECUTIVE SUMMARY

The overriding conclusion of this pilot study is that the laboratory equipment expenditure shortfall during the decade of 1971-81 was of the order of:

(a) $1,238,250,000 (assuming restoration of laboratories to the presumed 1971 status);

or

(b) $2,195,417,000 (assuming restoration to 1971 status plus additions to accommodate student enrollment growth as of 1981.)

Investments of this magnitude to bring engineering instructional laboratories to a modern state-of-the-art would represent an investment of about $400/FTE* Student annually or about $2000/BS Degree awarded. Assuming a life span of 10 years, annual expenditures of $580,000 per school to cover replacement costs based on 1971 status; and $1,029,900 per school to cover replacement costs based on 1981 status.

The tabular data on the following five pages present a summary of derived Figures of Merit based on inventory value and annual expenditures for each group of schools in the survey. While the maximum year values vary widely, the average annual and minimum year values are remarkably consistent between the various groups.

In the view of the Committee the tabular values may be used with a high degree of confidence in conjunction with "program weight factors" (see Table 6) to derive reliable estimates for an individual school.

*Full-Time Engineering

SCHOOLS BY GROUP

Below are listed the schools within the various categories. Schools in the study were grouped by size (i.e. number of accredited programs) and ownership (i.e. public or private).

Group 100 Schools (Public/9+Programs)

Auburn University
University of Florida
Georgia Institute of Technology
University of Illinois
Mississippi State University
Texas A&M University

Group 200 Schools (Public/5 to 8 Programs)

University of Central Florida
Clemson University
Kansas State University
University of Kentucky
Michigan State University
Montana State University
University of Nebraska
University of North Carolina at Charlotte
Tennessee Technological University
Washington State University

Group 300 Schools (Public/1 to 4 Programs)

University of North Dakota
Old Dominion University
Southeastern Massachusetts University
Southern Illinois University at Carbondale
Wichita State University
Youngstown State University

Group 400 Schools (Private-all)

Brown University
Clarkson College of Technology
Gannon University
The University of Tulsa

Group 500 Schools (All)

Summary of all schools

TABLE I

GROUP 100 SCHOOLS SUMMARY
1971-1981
YEARLY AVERAGE VALUE PER SCHOOL

BASED ON INVENTORY

FIGURE OF MERIT	MAXIMUM YEAR	ANNUAL AVERAGE	MINIMUM YEAR
TOTAL INVENTORY $	17,629,000	9,602,000	2,128,000
$/Program	1,469,000	800,000	177,000
$/Man Year	102,400	57,800	13,900
$/SCH	288	136	23
$/BS Degree	33,600	18,000	3,000
$/Head Count	6,140	3,070	620
$/FTE	8,730	4,520	1,180
$/Student Sta.	17,310	10,410	5,280

BASED ON ANNUAL EXPENDITURES

FIGURE OF MERIT	MAXIMUM YEAR	ANNUAL AVERAGE	MINIMUM YEAR
TOTAL EXPENDITURES $	617,700	344,400	211,100
$/Program	46,800	27,400	17,000
$/Man Year	3,940	2,310	1,530
$/SCH	6.25	4.76	2.96
$/BS Degree	840	590	390
$/Head Count	178	105	53
$/FTE	350	160	67
$/Student Sta.	1,902	597	154

NOTE: All Data are in 1981 dollars.

TABLE 2

GROUP 200 SCHOOLS SUMMARY
1971-1981
YEARLY AVERAGE VALUE PER SCHOOL

BASED ON INVENTORY

FIGURE OF MERIT	MAXIMUM YEAR	ANNUAL AVERAGE	MINIMUM YEAR
TOTAL INVENTORY $	4,284,000	2,568,000	795,000
$/Program	719,700	430,400	131,800
$/Man Year	77,000	43,600	12,100
$/SCH	245	128	23
$/BS Degree	22,500	12,500	2,700
$/Head Count	3,580	1,870	350
$/FTE	4,030	2,200	480
$/Student Sta.	21,140	12,210	2,950

BASED ON ANNUAL EXPENDITURES

FIGURE OF MERIT	MAXIMUM YEAR	ANNUAL AVERAGE	MINIMUM YEAR
TOTAL EXPENDITURES $	200,300	136,500	83,700
$/Program	32,600	22,300	13,900
$/Man Year	3,440	2,180	2,360
$/SCH	9.27	5.11	3.06
$/BS Degree	930	550	390
$/Head Count	154	83	50
$/FTE	173	95	58
$/Student Sta.	655	429	271

NOTE: All Data are in 1981 dollars.

TABLE 3

GROUP 300 SCHOOLS SUMMARY
1971-1981
YEARLY AVERAGE VALUE PER SCHOOL

BASED ON INVENTORY

FIGURE OF MERIT	MAXIMUM YEAR	ANNUAL AVERAGE	MINIMUM YEAR
TOTAL INVENTORY $	2,128,000	1,269,000	436,000
$/Program	608,000	363,000	125,000
$/Man Year	79,200	46,600	14,900
$/SCH	249	120	28
$/BS Degree	19,400	11,900	2,900
$/Head Count	3,330	1,790	340
$/FTE	5,060	2,790	600
$/Student Sta.	11,440	6,710	2,360

BASED ON ANNUAL EXPENDITURES

FIGURE OF MERIT	MAXIMUM YEAR	ANNUAL AVERAGE	MINIMUM YEAR
TOTAL EXPENDITURES $	129,800	70,400	37,000
$/Program	37,100	20,100	10,600
$/Man Year	4,460	2,450	1,440
$/SCH	9.30	6.24	4.44
$/BS Degree	970	650	420
$/Head Count	109	83	67
$/FTE	189	139	112
$/Student Sta.	645	397	195

NOTE: All Data are in 1981 dollars.

TABLE 4

GROUP 400 SCHOOLS SUMMARY
1971-1981
YEARLY AVERAGE VALUE PER SCHOOL

BASED ON INVENTORY

FIGURE OF MERIT	MAXIMUM YEAR	ANNUAL AVERAGE	MINIMUM YEAR
TOTAL INVENTORY $	1,981,000	1,080,000	185,000
$/Program	540,000	294,000	50,000
$/Man Year	91,800	53,000	7,500
$/SCH	287	154	15
$/BS Degree	23,200	13,000	1,800
$/Head Count	3,580	1,950	210
$/FTE	4,230	2,280	240
$/Student Sta.	27,700	14,500	2,500

BASED ON ANNUAL EXPENDITURES

FIGURE OF MERIT	MAXIMUM YEAR	ANNUAL AVERAGE	MINIMUM YEAR
TOTAL EXPENDITURES $	49,000	28,500	11,800
$/Program	12,300	7,100	3,000
$/Man Year	1,900	1,540	1,160
$/SCH	3.33	2.27	1.26
$/BS Degree	480	350	250
$/Head Count	59	49	39
$/FTE	69	56	44
$/Student Sta.	669	480	349

NOTE: All Data are in 1981 dollars.

TABLE 5

GROUP 500 SCHOOLS SUMMARY
1971-1981
YEARLY AVERAGE VALUE PER SCHOOL

BASED ON INVENTORY

FIGURE OF MERIT	MAXIMUM YEAR	ANNUAI AVERAGE	MINIMUM YEAR
TOTAL INVENTORY $	5,809,000	8,290,000	856,000
$/Program	792,000	456,000	126,000
$/Man Year	84,200	48,300	12,500
$/SCH	260	131	23
$/BS Degree	23,600	13,370	2,700
$/Head Count	3,950	2,080	380
$/FTE	5,180	2,780	610
$/Student Sta.	18,310	10,520	3,140

BASED ON ANNUAL EXPENDITURES

FIGURE OF MERIT	MAXIMUM YEAR	ANNUAL AVERAGE	MINIMUM YEAR
TOTAL EXPENDITURES $	230,200	152,600	100,500
$/Program	31,600	20,800	13,700
$/Man Year	3,250	2,290	1,600
$/SCH	6.54	4.55	3.52
$/BS Degree	660	520	400
$/Head Count	118	81	62
$/FTE	140	99	77
$/Student Sta.	761	506	342

NOTE: All Data are in 1981 dollars.

PILOT STUDY

Recognizing that while there is ample anecdotal evidence concerning the declining status of engineering laboratories, the Florida Deans of Engineering initiated a preliminary study of the problem. Subsequently, the aid of the Educational Data Committee of the Professional Engineers in Education Practice Division of NSPE was sought. It was recommended that efforts be made to obtain verifiable hard data to confirm (or deny) the problem.

Further, that in establishing a reliable estimate of the magnitude of the problem, parameter definitions should be used which are compatible with the pre-existing ASEE Planning Factors Study. See Appendix A for the survey instrument and definitions.

Should it be determined that the "pilot study" ought to be extended to a larger group of schools or continued for several years in order to establish trends, the present study data base is compatible with the ASEE Planning Factors Study. Equipment expenditure and inventory questions could be added to that study in a relatively easy fashion.

The Gross National Product Implicit Price Deflator (GNPIPD) has been used in the analysis of expenditures and inventory. All financial data reported herein are in terms of 1981 dollars.

It has been estimated (16) that the improvement in laboratory instrumentation is of the order of a factor of 10 every five years. This rapid advance of technology leads to a nominal "sensible use" lifespan of three to seven years for most engineering instructional laboratory equipment. Certainly, in general, equipment purchased 10 years ago is now obsolete. A very conservative lifespan of 10 years has been utilized in this study as basis for arriving at current inventory value.

The year 1970-71 was adopted as the base year for inventory purposes for two primary reasons: (a) it followed a decade of rather strong support for engineering education by states and various federal agencies (e.g., NSF, NDEA, ARPA, NASA, etc.), and (b) it preceded the aerospace-defense hiatus of the early seventies which was followed by a succession of lean years.

Schools invited to participate in the study were selected on a statistical basis in order to assure an appropriate mix by various factors (e.g., size, location, public, private, number of programs, etc.) The pilot study includes 26 colleges and universities of the 250 with one or more ABET-accredited engineering programs. Accordingly, the pilot group includes data on schools with 168 programs out of a national total of 1212 programs. The distribution of disciplines represented in the sample closely approximates the distribution in the national total.

All data reported herein are school "totals" without regard to discipline. The following "program weighting factors" derived from data reported by ECPD (18) during the period 1975-80 are included for the benefit of those who may want to use the data reported herein for comparative studies.

Table 6
Program Weight Factors

Discipline/Program	P.W.F.
Aeronautical	1.79
Agricultural	1.60
Chemical	1.19
Civil	.66
Electrical	1.08
Engineering	1.07
Engr. Science/Mechans	.63
Industrial	.43
Mechanical	.99
Met./Materials Science	1.89
Total	1.00

Three tables are displayed on the following pages for each group*, e.g.,

100.1	Basic Data
100.2	Figures of Merit Based on Inventory
100.3	Figures of Merit Based on Annual Expenditures

etc. Please note that all financial data are in terms of 1981 dollars. All tabular values are the average value for the group of schools reporting that particular item. Thus some "derived" figures of merit appear to differ from the ratios computed from the basic data summary due to the variation in the number of schools reporting on each data item.

*Refer to Schools by Group List on Page 7.

PILOT STUDY
LABORATORY EQUIPMENT INVENTORY/EXPENDITURES
NSPE - PROFESSIONAL ENGINEERS IN EDUCATION

A	B	C	D	E			F		G	H
Fiscal Year	Lab Equipment Expenditures ($1,000's)	Faculty Man Years MY	Annual SCH Produced	Degrees Awarded BS	MS	D	Enrollment Headcount	FTE	No. Student Stations	Research Expenditures ($ 1,000's)
1971-72	320.5	139.2	58,183	538	198	50	2,991	2,437	705	8,824
1972-73	272.3	138.9	57,957	549	185	47	2,812	2,288	705	8,855
1973-74	211.1	133.3	59,610	508	204	46	2,865	2,347	712	10,453
1974-75	218.4	136.8	63,453	477	198	46	3,125	2,461	716	9,646
1975-76	234.1	137.7	72,138	503	209	45	3,638	2,794	716	9,810
1976-77	311.7	142.3	78,922	528	203	48	4,067	3,065	744	10,160
1977-78	273.5	149.0	88,163	648	188	39	4,511	3,519	744	10,604
1978-79	461.2	147.0	95,438	722	189	46	4,880	3,781	735	10,626
1979-80	523.9	153.2	103,099	815	195	42	5,246	4,114	749	10,432
1980-81	617.7	161.6	111,613	928	206	43	5,616	4,333	722	11,821

NOTE: Data are average values per school reporting; 1981 dollars.

TABLE 100.1
BASIC DATA

PILOT STUDY
LABORATORY EQUIPMENT INVENTORY/EXPENDITURES
NSPE - PROFESSIONAL ENGINEERS IN EDUCATION

A	B	C	D	E	F	G	H	I	J
Fiscal Year	Lab Equipment Inventory ($1,000's)	$/MY (1,000's)	$/SCH	$/BS (1,000's)	$/H.C. (1000's)	$/FTE (1000's)	$/SS (1000's)	Ratio Res. Exp. / Lab. Inv.	$/Prog. (1,000's)
1971-72	17,629	102.4	288	33.6	6.14	8.73	17.31	.72	1,469
1972-73	15,923	94.0	264	28.2	5.85	8.12	16.15	.79	1,327
1973-74	14,127	86.4	223	29.1	5.21	7.11	14.49	1.06	1,177
1974-75	12,296	74.8	176	26.4	4.07	5.92	12.98	1.11	1,025
1975-76	10,404	65.1	132	20.9	2.93	4.33	11.13	1.34	867
1976-77	8,538	51.9	101	16.0	2.22	3.43	8.64	1.72	712
1977-78	6,652	39.5	71	10.3	1.61	2.34	6.87	2.25	554
1978-79	4,918	29.1	50	7.1	1.16	1.70	5.51	3.02	410
1979-80	3,400	21.2	35	4.9	.87	1.30	5.28	4.31	283
1980-81	2,128	13.9	23	3.0	.62	1.18	5.69	7.88	177

NOTE: Data are average values per school reporting; 1981 dollars.

TABLE 100.2
FIGURES OF MERIT-BASED ON INVENTORY

PILOT STUDY
LABORATORY EQUIPMENT INVENTORY/EXPENDITURES
NSPE - PROFESSIONAL ENGINEERS IN EDUCATION

A	B	C	D	E	F	G	H	I	J	K
Fiscal Year	Lab Equipment Expenditures ($1,000's)	$/MY (1,000's)	$/SCH	$/8S (1,000's)	$/H.C.	$/FTE	$/SS	Ratio Res. Exp. / Lab. Inv.	$/Prog. (1,000's)	Ann. Exp. % / Lab. Inv. (-1)
1971-72	320.5	2.12	6.25	.67	132	195	548	27.5	25.3	2.7
1972-73	272.3	1.92	6.14	.60	132	191	560	32.5	21.7	2.6
1973-74	211.1	1.61	4.53	.53	101	140	413	49.5	17.0	2.1
1974-75	218.4	1.56	3.96	.51	83	120	354	44.2	17.8	2.3
1975-76	234.1	1.53	3.28	.41	59	73	158	41.9	19.6	2.1
1976-77	311.7	1.96	3.79	.54	68	88	183	32.6	25.8	2.6
1977-78	273.5	1.65	2.96	.39	53	67	154	38.7	22.6	3.0
1978-79	461.2	3.17	4.63	.61	95	137	476	23.4	37.3	7.1
1979-80	523.9	3.60	5.73	.83	147	235	1,219	19.9	40.3	12.9
1980-81	617.7	3.94	6.31	.84	178	350	1,992	19.1	46.8	25.6

NOTE: Data are average values per school reporting; 1981 dollars.

TABLE 100.3
FIGURES OF MERIT-BASED ON ANNUAL EXPENDITURES

PILOT STUDY
LABORATORY EQUIPMENT INVENTORY/EXPENDITURES
NSPE - PROFESSIONAL ENGINEERS IN EDUCATION

A	B	C	D	E			F		G	H
				Degrees Awarded			Enrollment			
Fiscal Year	Lab Equipment Expenditures ($1,000's)	Faculty Man Years MY	Annual SCH Produced	BS	MS	D	Headcount	FTE	No. Student Stations	Research Expenditures ($ 1,000's)
1971-72	200.3	58.3	21,603	215	42	9	1,304	1,158	306	1,225
1972-73	113.4	58.0	21,171	235	51	9	1,232	1,094	307	1.272
1973-74	106.2	59.5	21,243	217	45	9	1,208	1,079	308	1,336
1974-75	137.5	59.5	23,117	208	44	7	1,331	1,168	309	1,433
1975-76	88.9	60.1	25,106	207	53	6	1,574	1,369	309	1,396
1976-77	83.7	61.4	27,362	213	56	4	1,677	1,455	309	1,690
1977-78	141.4	63.0	29,928	248	52	6	1,915	1,642	330	1,609
1978-79	156.3	66.0	32,294	285	48	4	2,136	1,869	330	1,584
1979-80	179.3	68.6	34,879	330	48	5	2,326	1,972	334	1,600
1980-81	158.0	70.5	37,508	339	48	5	2,534	2,136	354	1,691

NOTE: Data are average values per school reporting; 1981 dollars.

TABLE 200.1
BASIC DATA

PILOT STUDY
LABORATORY EQUIPMENT INVENTORY/EXPENDITURES
NSPE - PROFESSIONAL ENGINEERS IN EDUCATION

A	B	C	D	E	F	G	H	I	J
Fiscal Year	Lab Equipment Inventory ($1,000's)	$/MY (1,000's)	$/SCH	$/BS (1,000's)	$/H.C. (1000's)	$/FTE (1000's)	$/SS (1000's)	Ratio Res. Exp. / Lab. Inv.	$/Prog. (1,000's)
1971-72	4,284	77.0	245	22.5	3.58	4.03	21.14	.25	719.7
1972-73	3,933	69.7	223	18.3	3.36	3.82	19.34	.29	660.8
1973-74	3,562	60.5	202	17.3	3.07	3.54	17.38	.34	597.8
1974-75	3,210	55.0	176	16.9	2.54	3.04	15.46	.42	538.0
1975-76	2,791	47.3	138	14.9	1.89	2.27	13.35	.46	467.5
1976-77	2,357	39.1	105	13.0	1.50	1.79	11.23	.63	394.7
1977-78	1,963	32.0	76	8.9	1.09	1.33	9.09	.70	329.0
1978-79	1,579	24.6	56	6.1	.79	.99	7.06	.90	263.4
1979-80	1,204	18.5	39	4.3	.57	.73	5.13	1.13	200.9
1980-81	795	12.1	23	2.7	.35	.48	2.95	1.94	131.8

NOTE: Data are average values per school reporting; 1981 dollars.

TABLE 200.2
FIGURES OF MERIT-BASED ON INVENTORY

PILOT STUDY
LABORATORY EQUIPMENT INVENTORY/EXPENDITURES
NSPE - PROFESSIONAL ENGINEERS IN EDUCATION

A	B	C	D	E	F	G	H	I	J	K
Fiscal Year	Lab Equipment Expenditures ($1,000's)	$/MY (1,000's)	$/SCH	$/BS (1,000's)	$/H.C.	$/FTE	$/SS	Ratio Res. Exp. / Lab. Inv.	$/Prog. (1,000's)	Ann. Exp. % / Lab. Inv. (-1)
1971-72	200.3	3.44	9.27	.93	154	173	655	6.13	32.6	4.8
1972-73	113.4	1.96	5.36	.48	92	104	369	11.22	19.0	2.9
1973-74	106.2	1.78	5.00	.49	88	98	345	12.58	17.3	2.9
1974-75	137.5	2.31	5.95	.66	103	118	445	10.42	22.2	4.1
1975-76	88.9	1.48	3.54	.43	56	65	288	15.70	14.4	2.9
1976-77	83.7	1.36	3.06	.39	50	58	271	20.19	13.9	3.1
1977-78	141.4	2.24	4.72	.57	74	86	428	11.38	23.2	5.8
1978-79	156.3	2.37	4.84	.55	73	84	474	10.13	24.7	8.1
1979-80	179.3	2.61	5.14	.54	77	91	537	8.92	29.7	11.7
1980-81	158.0	2.24	4.21	.47	62	74	473	10.70	25.7	14.0

NOTE: Data are average values per school reporting; 1981 dollars.

TABLE 200.3
FIGURES OF MERIT-BASED ON ANNUAL EXPENDITURES

PILOT STUDY
LABORATORY EQUIPMENT INVENTORY/EXPENDITURES
NSPE - PROFESSIONAL ENGINEERS IN EDUCATION

A	B	C	D	E			F		G	H
				Degrees Awarded			Enrollment			
Fiscal Year	Lab Equipment Expenditures ($1,000's)	Faculty Man Years MY	Annual SCH Produced	BS	MS	D	Headcount	FTE	No. Student Stations	Research Expenditures ($ 1,000's)
1971-72	75.7	27.7	13,327	131	19	0	650	474	241	243
1972-73	49.9	28.0	11,658	118	15	0	583	424	241	349
1973-74	37.0	28.6	11,965	115	11	0	590	427	241	627
1974-75	48.2	29.6	10,916	102	14	0	644	465	241	917
1975-76	68.0	29.8	13,163	94	15	0	755	537	243	825
1976-77	58.6	29.8	13,036	101	17	1	827	580	250	800
1977-78	65.0	29.4	14,294	119	20	1	958	658	254	899
1978-79	76.4	29.5	15,217	143	19	1	1,045	693	255	784
1979-80	129.8	30.2	15,530	151	20	1	1,115	719	256	840
1980-81	95.3	31.1	17,362	157	17	1	1,223	807	256	1,011

NOTE: Data are average values per school reporting; 1981 dollars.

TABLE 300.1
BASIC DATA

PILOT STUDY
LABORATORY EQUIPMENT INVENTORY/EXPENDITURES
NSPE - PROFESSIONAL ENGINEERS IN EDUCATION

A	B	C	D	E	F	G	H	I	J
Fiscal Year	Lab Equipment Inventory ($1,000's)	$/MY (1,000's)	$/SCH	$/BS (1,000's)	$/H.C. (1000's)	$/FTE (1000's)	$/SS (1000's)	Ratio Res. Exp. / Lab. Inv.	$/Prog. (1,000's)
1971-72	2,128	79.2	249	19.4	3.21	5.06	11.44	.11	608
1972-73	1,942	71.9	214	17.7	3.33	5.03	10.47	.18	555
1973-74	1,739	64.6	172	15.6	2.96	4.54	9.37	.36	497
1974-75	1,543	57.5	154	16.2	2.40	3.71	8.36	.59	441
1975-76	1,362	50.0	116	15.3	1.82	2.83	7.34	.61	389
1976-77	1,164	42.6	97	11.7	1.45	2.26	5.88	.69	333
1977-78	968	35.1	73	8.6	1.03	1.63	4.78	.93	276
1978-79	776	28.1	56	6.2	.75	1.23	3.89	1.01	222
1979-80	630	22.4	45	4.9	.56	.96	3.23	1.33	180
1980-81	436	14.9	28	2.9	.34	.60	2.36	2.32	125

NOTE: Data are average values per school reporting; 1981 dollars.

TABLE 300.2
FIGURES OF MERIT-BASED ON INVENTORY

PILOT STUDY
LABORATORY EQUIPMENT INVENTORY/EXPENDITURES
NSPE - PROFESSIONAL ENGINEERS IN EDUCATION

A	B	C	D	E	F	G	H	I	J	K
Fiscal Year	Lab Equipment Expenditures ($1,000's)	$/MY (1,000's)	$/SCH	$/BS (1,000's)	$/H.C.	$/FTE	$/SS	Ratio Res. Exp. / Lab. Inv.	$/Prog. (1,000's)	Ann. Exp. / Lab. Inv. (-1)
1971-72	75.7	2.88	6.87	.57	108	187	302	3.21	21.6	3.3
1972-73	49.9	1.82	5.31	.52	89	142	301	6.98	14.3	2.3
1973-74	37.0	1.44	4.44	.42	71	125	195	16.95	10.6	1.9
1974-75	48.2	1.73	5.40	.58	77	125	305	19.02	13.8	2.8
1975-76	68.0	2.29	7.35	.97	95	157	501	12.13	19.4	4.4
1976-77	58.6	2.00	5.79	.67	78	121	383	13.65	16.7	4.3
1977-78	65.0	2.27	5.82	.66	70	117	388	13.83	18.6	5.6
1978-79	76.4	2.65	6.04	.60	70	116	422	10.26	21.8	7.8
1979-80	129.8	4.46	9.30	.89	109	189	645	6.47	37.1	16.7
1980-81	95.3	2.97	6.07	.57	67	112	530	10.61	27.2	15.1

NOTE: Data are average values per school reporting; 1981 dollars.

TABLE 300.3
FIGURES OF MERIT-BASED ON ANNUAL EXPENDITURES

PILOT STUDY
LABORATORY EQUIPMENT INVENTORY/EXPENDITURES
NSPE - PROFESSIONAL ENGINEERS IN EDUCATION

A	B	C	D	E			F		G	H
				Degrees Awarded			Enrollment			
Fiscal Year	Lab Equipment Expenditures ($1,000's)	Faculty Man Years MY	Annual SCH Produced	BS	MS	D	Headcount	FTE	No. Student Stations	Research Expenditures ($ 1,000's)
1971-72	13.8	24.6	9,582	126	36	5	661	628	76	1,550
1972-73	11.8	23.8	9,352	132	28	7	627	593	76	1,608
1973-74	15.3	23.8	9,016	144	30	7	624	591	84	1,593
1974-75	15.7	23.7	9,549	126	30	9	665	632	84	1,428
1975-76	29.7	24.8	11,453	120	30	6	796	758	84	1,408
1976-77	33.4	26.2	12,812	156	29	4	879	839	86	1,466
1977-78	39.6	27.2	13,772	176	34	4	934	891	86	1,670
1978-79	44.7	28.6	14,056	185	21	4	973	929	86	1,876
1979-80	49.0	29.6	14,703	208	24	6	992	949	88	2,149
1980-81	31.7	31.5	15,662	200	29	3	1,046	999	88	2,121

NOTE: Data are average values per school reporting; 1981 dollars.

TABLE 400.1
BASIC DATA

PILOT STUDY
LABORATORY EQUIPMENT INVENTORY/EXPENDITURES
NSPE - PROFESSIONAL ENGINEERS IN EDUCATION

A	B	C	D	E	F	G	H	I	J
Fiscal Year	Lab Equipment Inventory ($1,000's)	$/MY (1,000's)	$/SCH	$/BS (1,000's)	$/H.C. (1000's)	$/FTE (1000's)	$/SS (1000's)	Ratio Res. Exp. / Lab. Inv.	$/Prog. (1,000's)
1971-72	1,981	91.8	287	22.1	3.58	4.18	27.7	.94	540
1972-73	1,777	89.3	280	23.?	3.48	4.07	25.0	.99	485
1973-74	1,575	84.3	282	17.2	3.58	4.23	20.6	1.13	430
1974-75	1,372	74.3	220	16.5	2.85	3.30	18.1	1.10	374
1975-76	1,171	61.8	154	17.2	1.95	2.28	15.7	1.28	319
1976-77	968	44.0	121	10.9	1.53	1.79	12.4	1.66	264
1977-78	776	34.9	89	8.8	1.13	1.32	10.1	2.43	212
1978-79	589	25.3	56	8.7	.72	.83	7.8	3.46	161
1979-80	401	16.8	38	3.3	.49	.57	5.2	5.65	109
1980-81	185	7.5	15	1.8	.21	.24	2.5	11.66	50

NOTE: Data are average values per school reporting; 1981 dollars.

TABLE 400.2
FIGURES OF MERIT-BASED ON INVENTORY

PILOT STUDY
LABORATORY EQUIPMENT INVENTORY/EXPENDITURES
NSPE - PROFESSIONAL ENGINEERS IN EDUCATION

A	B	C	D	E	F	G	H	I	J	K
Fiscal Year	Lab Equipment Expenditures ($1,000's)	$/MY (1,000's)	$/SCH	$/BS (1,000's)	$/H.C.	$/FTE	$/SS	Ratio Res. Exp. / Lab. Inv.	$/Prog. (1,000's)	Ann. Exp. % / Lab. Inv. (-1)
1971-72	13.8	1.16	1.44	.25	39	46	443	112.3	3.5	1.2
1972-73	11.8	1.25	1.26	.34	44	52	420	136.3	3.0	1.2
1973-74	15.3	1.44	1.70	.28	59	69	448	104.1	3.8	1.5
1974-75	15.7	1.36	1.64	.28	49	56	422	91.0	3.9	1.6
1975-76	29.7	1.90	2.59	.48	56	61	459	47.4	7.4	2.0
1976-77	33.4	1.81	2.61	.40	57	63	423	43.9	8.4	2.4
1977-78	39.6	1.75	2.88	.37	52	57	589	42.2	9.9	3.9
1978-79	44.7	1.62	3.18	.42	43	46	669	42.0	11.2	5.3
1979-80	49.0	1.75	3.33	.33	55	62	577	43.9	12.3	8.0
1980-81	31.7	1.35	2.02	.30	40	44	349	66.9	7.9	7.5

NOTE: Data are average values per school reporting; 1981 dollars.

TABLE 400.3
FIGURES OF MERIT-BASED ON ANNUAL EXPENDITURES

PILOT STUDY
LABORATORY EQUIPMENT INVENTORY/EXPENDITURES
NSPE - PROFESSIONAL ENGINEERS IN EDUCATION

A	B	C	D	E			F		G	H
Fiscal Year	Lab Equipment Expenditures ($1,000's)	Faculty Man Years MY	Annual SCH Produced	Degrees Awarded BS	MS	D	Enrollment Headcount	FTE	No. Student Stations	Research Expenditures ($ 1,000's)
1971-72	170.5	64.7	26,088	257	72	16	1,443	1,214	340	2,802
1972-73	119.8	64.5	25,456	265	70	15	1,354	1,138	340	2,860
1973-74	100.5	63.9	25,883	249	71	15	1,358	1,145	343	3,317
1974-75	116.8	64.9	27,309	233	70	15	1,484	1,222	344	3,208
1975-76	108.5	65.6	30,836	236	77	13	1,742	1,412	344	3,207
1976-77	122.8	67.4	33,408	251	77	13	1,910	1,530	352	3,403
1977-78	138.6	69.6	36,951	299	73	12	2,142	1,733	362	3,530
1978-79	191.0	70.5	39,794	337	70	13	2,338	1,894	362	3,530
1979-80	227.4	73.3	42,721	382	72	13	2,515	2,020	366	3,547
1980-81	230.2	76.4	46,241	411	74	12	2,714	2,161	370	3,937

NOTE: Data are average values per school reporting; 1981 dollars.

TABLE 500.1
BASIC DATA

PILOT STUDY
LABORATORY EQUIPMENT INVENTORY/EXPENDITURES
NSPE - PROFESSIONAL ENGINEERS IN EDUCATION

A	B	C	D	E	F	G	H	I	J
Fiscal Year	Lab Equipment Inventory (1,000's)	$/MY (1,000's)	$/SCH	$/BS (1,000's)	$/H.C. (1000's)	$/FTE (1000's)	$/SS (1000's)	Ratio Res. Exp. / Lab. Inv.	$/Prog. (1,000's)
1971-72	5,809	84.2	260	23.6	3.95	5.18	18.31	.44	792
1972-73	5,276	77.4	236	20.6	3.82	4.97	16.77	.51	721
1973-74	4,715	69.6	208	19.0	3.50	4.56	14.87	.65	646
1974-75	4,157	61.9	176	18.4	2.82	3.78	13.22	.78	572
1975-76	3,565	53.3	133	16.4	2.07	2.80	11.44	.89	494
1976-77	2,966	43.0	104	12.9	1.62	2.21	9.35	1.16	414
1977-78	2,382	34.6	76	9.0	1.18	1.60	7.56	1.47	337
1978-79	1,832	26.5	55	6.7	.84	1.16	5.95	1.79	263
1979-80	1,337	19.8	40	4.4	.61	.88	4.58	2.59	196
1980-81	856	12.5	23	2.7	.38	.61	3.14	6.14	126

NOTE: Data are average values per school reporting; 1981 dollars.

TABLE 500.2
FIGURES OF MERIT-BASED ON INVENTORY

PILOT STUDY
LABORATORY EQUIPMENT INVENTORY/EXPENDITURES
NSPE - PROFESSIONAL ENGINEERS IN EDUCATION

A	B	C	D	E	F	G	H	I	J	K
Fiscal Year	Lab Equipment Expenditures ($1,000's)	$/MY (1,000's)	$/SCH	$/BS (1,000's)	$/H.C.	$/FTE	$/SS	Ratio Res. Exp. / Lab. Inv.	$/Prog. (1,000's)	Ann. Exp. / Lab. Inv. (-1)
1971-72	170.5	3.17	6.54	.66	118	140	616	16.4	24.1	4.6
1972-73	119.8	2.03	4.71	.45	88	105	468	23.9	16.1	2.8
1973-74	100.5	1.60	3.88	.40	74	88	363	33.0	13.7	2.5
1974-75	116.8	1.95	4.28	.50	79	96	418	27.5	16.6	3.5
1975-76	108.5	1.78	3.52	.46	62	77	374	29.6	15.7	3.5
1976-77	122.8	1.75	3.68	.49	64	80	342	27.7	16.5	3.5
1977-78	138.6	2.14	3.75	.46	65	80	450	25.5	19.9	5.4
1978-79	191.0	2.51	4.80	.57	82	101	510	18.5	25.2	7.5
1979-80	227.4	3.25	5.32	.60	90	113	761	15.6	31.6	12.9
1980-81	230.2	2.72	4.98	.56	85	107	760	17.1	28.8	14.7

NOTE: Data are average values per school reporti ;; 1981 dollars.

TABLE 500.3
FIGURES OF MERIT-BASED ON ANNUAL EXPENDITURES

CONCLUSIONS

Review of the tabular data reveals that the average laboratory equipment inventory per school declined from $5,809,000 to $856,000 during the period 1971-81. Based on 250 schools with one or more accredited programs, this leads to the conclusion that the cost of modernizing engineering laboratories (at the 1971 level) will be $1,238,250,000. If one considers the difference in enrollments (FTE) between 1981 and 1971 this figure increases to $2,195,417,000.

Considering the lifespan of 10 years used in this study, expenditures per school for laboratory equipment should have been at the level of $580,900 annually. Actual expenditures during the decade averaged $152,600 per school per year.

While this shortfall appears on the surface to be a staggering sum, an expenditure for laboratory equipment of about $400/FTE student annually or of $2000/BS Degree awarded could have prevented this decline in laboratory quality. The investment required to bring engineering instructional laboratories up to date with state-of-the-art equipment should become a prime national priority.

While not directly a part of this study, it is interesting to note that the following workload changes have occurred:

(a) SCH* produced per faculty member up 50%

(b) BS degrees awarded up 60%

(c) FTE enrollment up 78%

while the number of laboratory "student stations" increased by only 9% and equipment inventory declined to about 15% of 1971 values.

The conclusion reached by AAES and ASEE in March 1980. . ."that the engineering education system is currently stretched to (or beyond) its limit"

*Student Credit Hours

should be underscored (19). Clearly the problems of large class size, high student-to-faculty ratios, deteriorating physical plants, inadequate equipment, and inability to acquire laboratory equipment commensurate with present-day technological advances in industry are too widespread to be ignored. They are too pervasive to be regarded as transient.

Continuing obsolescence of laboratory equipment and instruments has placed many schools in the position of not being representative of modern professional practice. New technologies, apparatus and methodologies are evolving more rapidly in industry, and lack of up-to-date equipment and instruments within the university exacerbates the situation. Rapid evolution of such fields as robotics, microelectronics, computer aided design, optics, spectrographics, electron microscopy, computer graphics,. . .etc. has left the universities in a teaching mode far behind current professional practice. Students are not being adequately prepared to work with confidence in many areas of engineering.

Provision for continuing modernization of engineering laboratory equipment must be made.

LITERATURE CITED

1. Kersten, R. D. "Elements of the Crisis in Engineering Education," Winter Meeting, NSPE, January 18-23, 1982. (See also Professional Engineer, March 1982).

2. Allison, D. "The University and Regional Prosperity," International Science and Technology, April 1961.

3. Martin, T. L. "Industry-Education Interaction: Synergistic Symbiosis," Engineering Education, May 1969.

4. _____. "IEEE Leaders Question Engineering Manpower Shortage," The Institute, Vol. 6, No. 1, January 1982.

5. _____. "Education and Utilization of the Engineer 1980-2000," The Bridge, Vol. 11, No. 3, Fall 1981.

6. Samuelson, R. J. "A New Engineering Boom Creates Campus Problems," Los Angeles Times, December 15, 1981.

7. Kersten, R. D. "Professional Schools: The Debate Continues," ASCE Reprint 81-518, St. Louis, Missouri, October 1981.

8. Main, Jeremy. "Why Engineering Deans Worry a Lot," Fortune, January 11, 1982.

9. Fowler, W. A. and Shapero, D. C. "Scientific Instrumentation," Science, Vol. 216, No. 4547, May 14, 1982.

10. _____. "Florida's Engineering Schools and Unplanned Obsolescence: The Equipment Gap," Journal, Florida Engineering Society, February 1980.

11. Glower, D. D. "Civilization Beyond the '80s: Is There Hope for the U.S.?" Engineering Education, February 1982.

12. Page, R. H. "One Billion for Instructional Equipment," Engineering Education News, June 1982.

13. Drucker, D. C. "The Crisis in Engineering Education," (unpublished statement to AAES, April 22, 1981.)

14. _____. "Condition of Engineering Education: Crisis or Catalyst?" (unpublished statement to AAES, May 6, 1982.)

15. _____. "Report on Quality of Engineering Programs at State University System Colleges of Engineering," Florida Engineering Society, December 1980.

16. Abelson, P. H. "Obsolete Instrumentation at Universities," Science, Vol. 200, No. 4346, June 9, 1978.

17. Gloyna, E., et al. "Presentation to Coordination Board, Texas College and University System Study Committee," Texas Society of Professional Engineers, November 7, 1979.

18. Burnet, George, et al. "ECPD Survey of Institutional Data" (1975-76; 1976-77; 1977-78; 1978-79; 1979-80), Engineering Education, Nov. 1976; Nov. 1977; April 1978; Feb. 1979; Feb. 1980.

19. _____. "Memorandum on Engineering Education," a response by AAES/ASEE to President Carter's memorandum of February 8, 1980.

NSPE/PEE
LABORATORY EQUIPMENT STUDY

I. Definitions and Instructions
(Column Headings Correspond to Instruction Code)

A. Fiscal Year
July 1, through June 30. Report all data for 12-month period.

B. Laboratory Equipment Expenditures
Report the total expenditures for each fiscal year for equipment items used for teaching and research. This item is intended to represent the support from institutional funds for laboratory equipment. (Do not report equipment purchased through separately budgeted research). Data should be for the then-current dollars basis. We will apply appropriate price inflators in our analysis to arrive at 1980-81 dollars. Do not include computer equipment expenditures unless such equipment is directly a part of an instructional laboratory. Exclude central computer center "number crunching" type expenditures.

C. Faculty Man Years
FTE refers to the % time appointed. The man year refers to the duration of the appointment.

12-month appointment @ 1.00 FTE = 1 MY
10-month appointment @ 1.00 FTE = .833 MY
9-month appointment @ 1.00 FTE = .75 MY

Report the number of faculty manyears funded specifically for the on-campus instructional program. Instructional activities include undergraduate and graduate level teaching, thesis and dissertation supervision, departmental research, counseling, and administration. Do not include manyears for counseling and administration. Do not include manyears for separately funded research or public service activities. Please report only those persons holding the academic rank of instructor or equivalent, or higher.

D. SCH Produced
Student credit hours (SCH's) are a measure of the instructional load for all courses taught by the engineering faculty during a 12-month period. One student taking a three-semester-hour course for one semester accounts for 3 SCH's. If your institution is on an academic term other than semesters, please make the appropriate conversion and report on a semester basis.

E. Degrees, Awarded
Report total number of degrees awarded for the 12-month period July 1 through June 30 each year.

F. Enrollment

Report the number of total head count (for Fall term) of engineering students pursuing full or part-time programs freshman through graduate. Similarly, report the number of FTE students (for Fall term) of engineering students freshman through graduate as determined, e.g., 15 SCH per FTE undergraduate; 12 SCH per FTE graduate.

G. Number of Student Stations

Report the total number of student stations of instructional laboratories and associated equipment, e.g., a typical Electrical Engineering student station...50 square feet of floor space, bench, oscilloscope, power supply, function generator, digital multimeter, etc. The occupancy rate may exceed the number of student stations and stations may be used more or less frequently depending on scheduling frequency...however, the given setup of equipment is essential to program operation whether student use is one or one hundred in a given time frame.

H. Separately Budgeted Research Expenditures

Report separately budgeted research expenditures (total $) as typically reported to ASEE Research and Graduate Study survey. (cf for example Table C of March issue of Engineering Education).

I. Base Year Inventory (1970-71)

Please report the dollar value of your laboratory equipment inventory on a "book value" or "acquisition cost" basis. If any other basis is used please so indicate under remarks.

J. Remarks

If reports/data are not available for all years of this study please give best estimates possible and explain under remarks. Please report any apparent anomalies in your data, e.g., where resources are shared with a non-engineering unit, start up of new program(s) or phase out of old program(s), change in accounting basis, etc.

K. Lab Credits Required

Report for typical degree program at your institution the number of required laboratory credits.

II. Discussion

A. Nearly all of this data may have been reported in some years to:

ASEE Planning Factors Study
EMC Enrollment and degree data
ASEE Research and Graduate Study Directory

Please utilize such data for any years for which they may be available and report remaining years on a comparable basis.

B. We desire data on a College-wide basis at this time. However, if this is not possible feel free to supply data on a program/department basis for one or more units of your College.

C. Our objective is to develop several data plots of Figures of Merit vs time for a pilot group of schools considering factors of size, complexity, research activity, number of accredited programs, etc. We will apply depreciation and inflation rates in our analysis. Figures of Merit derivable from the data sought herein include:

   a. Dollars/Head Count Student
   b. Dollars/FTE Student
   c. Dollars/Degree/Level
   d. Dollars/Faculty Manyear
   e. Dollars/SCH
   f. Dollars/Student Station
   etc.

D. We have discussed this activity with a number of persons within NSPE, ASEE, and ABET. Assuming some sensible results from this pilot study, we would seek to include future data requests within the ASEE Planning Factors Study.

COMPARATIVE STUDY
LABORATORY EQUIPMENT INVENTORY/EXPENDITURES
NSPE - PROFESSIONAL ENGINEERS IN EDUCATION

A	B	C	D	E			F		G	H
Fiscal Year	Lab Equipment Expenditures ($1,000's	Faculty Man Years MY	SCH Produced	Degrees Awarded BS	MS	D	Enrollment Headcount	FTE	No. of Student Stations	Separately Budgeted Research Expenditures ($1,000's)
1971-72										
1972-73										
1973-74										
1974-75										
1975-76										
1976-77										
1977-78										
1978-79										
1979-80										
1980-81										

(I) Base Year Inventory (1970-71) $ _____

Data Reported are for (a) College _____

(b) Program/Dept. _____

Indicate Discipline _____

(J) Lab Credits Required

BS _____

MS _____

PhD _____

(K) Remarks:

Name and Mailing Address of Institution:

_____

_____

_____

Person Responsible for Data:

Name: _____

Telephone: _____

Appendix 4